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*A Consideration of the
Results in 327 Cases of Tracheotomy,*

*PERFORMED AT THE BOSTON CITY HOSPITAL
FROM 1864 TO 1887.*

BY

ROBERT W. LOVETT, M. D., AND JOHN C. MUNRO, M. D.,
Formerly House Surgeons at the Hospital.

FROM

THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES.

JULY, 1887.



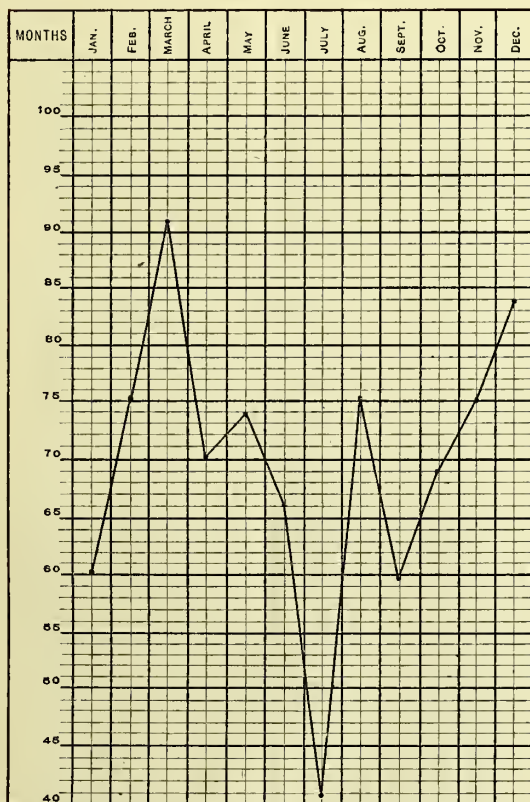


TABLE I. Curve of monthly percent of deaths after tracheotomy at the Boston City Hospital, 1881-85 inclusive.

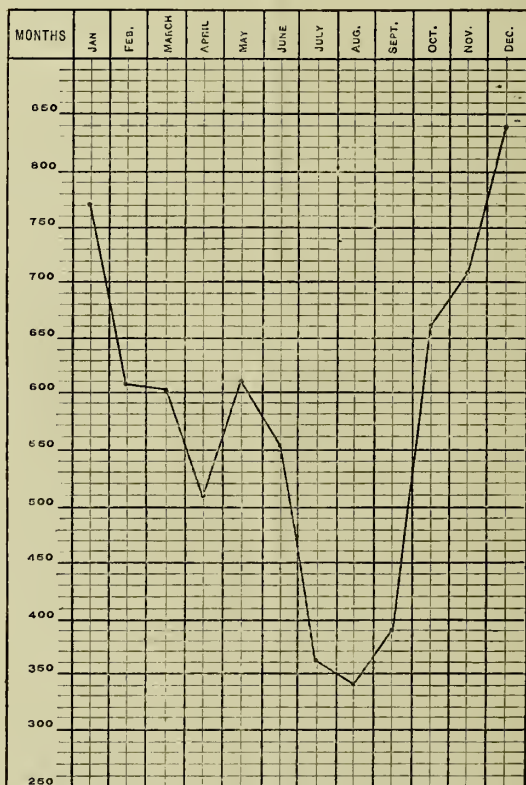


TABLE II. Curve of actual number of cases of diphtheria in Boston, by the month for 1881-85 inclusive.

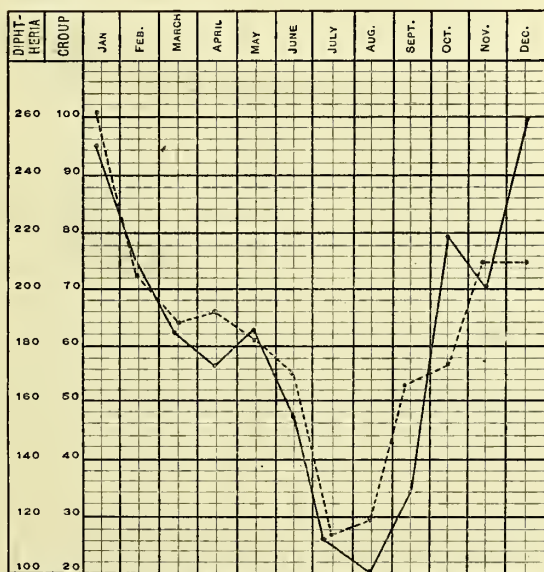


TABLE III. Curve of number of deaths by the month from Diphtheria and from Croup, 1881-85, inclusive.
Diphtheria ————— Croup - - - - -

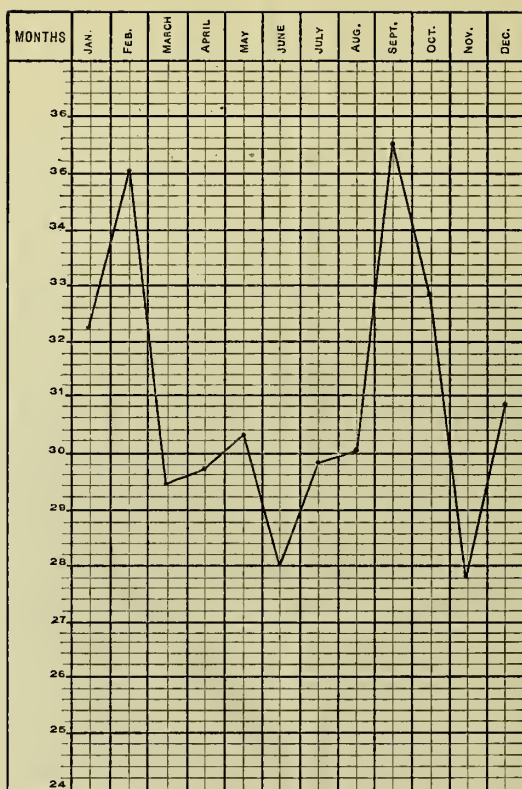


TABLE IV. *Curve of mortality percent of diphtheria, 1881-85 incl. Proportion of fatal cases to cases reported.*

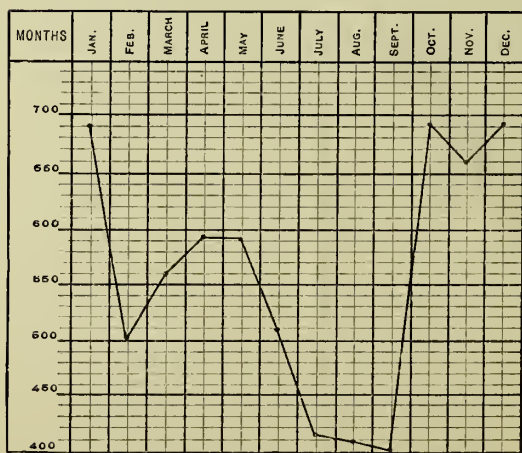


TABLE V. *Curve of prevalence of scarlet fever by the month, 1881-85 inclusive. Number of cases reported.*

A CONSIDERATION OF THE RESULTS IN 327 CASES OF TRACHEOTOMY,

PERFORMED AT THE BOSTON CITY HOSPITAL FROM 1864 TO 1887.

BY ROBERT W. LOVETT, M.D., AND JOHN C. MUNRO, M.D.,

FORMERLY HOUSE SURGEONS AT THE HOSPITAL.

THE operation of tracheotomy was performed for croup 327 times at the Boston City Hospital from the time of its foundation in 1864 to January, 1887. Up to the year 1880, only 30 tracheotomies had been done, so that the greater part of the operations have been performed in the last six years. It should be noted, in passing, that a bad class of cases would naturally come to a city hospital for operation. In most instances being treated at home, medically, until an operation has become imperative and long after it has become advisable, they are brought hurriedly for operation often in a hopelessly bad condition. If the parents wish or if an operation seems likely to afford even temporary relief to the patient, tracheotomy is performed, and thus many hopeless cases are yearly operated upon; all of which are included in the analysis. We are indebted to the visiting surgeons of the hospital for permission to publish the following cases.

Of the 327 cases, 232 died and 95 (29.05 per cent.) recovered. The causes of death were, septicæmia in 62 cases, extension of the diphtheritic process to the trachea and bronchi (doubtless including many pneumonia cases) in 101 cases, exhaustion in 12 cases, death on the table in 10 cases, heart failure in 6 cases, various causes (pneumonia, peritonitis, scarlet fever, nephritis, embolism, marasmus) in 6 cases, undetermined in 35 cases.

Autopsies were so few that a clinical estimate of the cause of death had to serve in most cases; such a classification is approximate at best and the distinctions were by no means always clear. When death was preceded by gradually increasing dyspnoea it was considered that extension of the diphtheritic process to the bronchi was the cause of death and the truth of this was often proved by autopsy. In other cases profound septic poisoning was evident as the chief cause of death. These

are the two great classes into which the majority of cases fall, other causes of death seeming incidental. Children with septicæmic symptoms died more quickly after operation than those dying by extension of the process to the bronchi. An average of the two classes showed that septicæmic patients died on the average two days after operation, while children dying by extension lived three days.

The relation of the number of deaths from extension to those from septicæmia is shown below.

	Extension.	Septicæmia.
In all the fatal cases	1 $\frac{2}{3}$	to 1
In children under 2 years	3 $\frac{1}{3}$	to 1
In children from 2 to 10 years	1 $\frac{1}{3}$	to 1

It can be seen from this that young children are particularly liable to that distressing cause of death, extension of the process to the bronchi. When this happens there is no euthanasia, death is the slowest and most painful of suffocations, and only when septicæmia to the point of stupefaction is present at the same time does the child escape a horrible amount of suffering. The frequency of this painful ending then is not to be lost sight of in recommending the operation as a means of euthanasia, especially in children under two years of age.

10 cases died on the table. 2 of these evidently died of heart failure, for they stopped breathing before the trachea was opened and had but slight hemorrhage. 4 had profuse hemorrhage, and 2 died of shock some little time after the tube was put in place and everything seemed favorable. In the remaining 2 cases the records are not full. The 6 cases classed as heart failure did not die on the table, but from the first to the fifth day after operation.

An attempt was made to find the ultimate result in the 95 patients that recovered. 23 cases recovered in 1886, and were considered as too recent to be of value.

Of the 72 that recovered previous to January, 1886, 56 have been personally investigated, while 16 could not be found. The research was made especially difficult by the fact that it was so common for the parents to move after an attack of diphtheria and the consequent investigation by the Board of Health. Of the 72 families, 57 had moved at least once. 15 cases were seen from one to two years after operation; 16 cases in three years; 12 cases in four years; 2 cases in five years; 6 cases in six years; 4 cases in seven years; 1 case in twenty-one years. 26 have never been ill in any way since recovery from the operation. 7 have had pneumonia, measles, or mumps, but have fully recovered, no one of them having had croup at the time of illness. 2 have had diphtheria a second time without laryngeal complication; 1, nine years

old, two years after operation, and 1, twenty years old, four years after.

With eight exceptions, the patients have been free from any attack of croup since operation. One, five years old, operated on in 1885, has had two attacks, one of which was quite severe. One, ten years old, operated on in 1884, has had one or two attacks, and is in poor general condition. One, four years old, operated on in 1885, is apt to be croupy with a slight cold. One, six years old, operated on in 1885, the same. One, fourteen years old, operated on in 1883, the same. One, ten years old, operated on in 1885, has croupy cough. One, seven years old, operated on in 1884, was liable to be croupy for a while after operation, but is not so now. One, eleven years old, operated on in 1883, the same.

Of complications coming after operation, one had nephritis and paralysis, but recovered; one had nephritis for four months. One had "abscesses." One, a boy ten years old, operated on in 1881, could not blow his nose for two years, but is well now.

There have been no deaths in the 56 cases investigated, and there is no reason to believe that these are any more favorable than the 16 that could not be found.

As to present condition, 53 may be said to be in good general health: 10 to 15 are said to take cold more easily than before. That it is not a very serious matter may be seen by the fact that only 6 are said to be liable to sore throats, of whom 2 have tonsillitis at times, and the remainder are liable to have sore throats when they catch cold. Of the 3 who were found not to be in good condition, one, six years old, operated on a year and a half ago, has phthisis, but no laryngeal symptoms. The second, noted above, is in bad general condition, hoarse, and croupy. The third is a delicate boy, five years old, with no positive signs of trouble except a tendency to croup and illness.

The voice is clear in all but 4 cases; in one of the latter, a girl of thirteen, operated on two years ago, the voice is not so clear as before operation, and she cannot sing so high as before. The second, four years old, has a fairly clear voice, but it is said to be less so than before operation, two years ago; two are said to be hoarse when they have slight colds. The scars in all cases are healed and are more or less conspicuous according to the severity of the original wound; none were found adherent, and in no instance had the scar travelled downward toward the sternum as mentioned by Neukomm.¹ In nearly all the cases a linear depression in the trachea admitting the edge of the finger-nail could be felt at the site of the original wound, but in one case operated on in 1880, by the low operation, no nick was felt in the trachea.

There were 4 cases of stenosis which are noted later in the article.

¹ Neukomm: *Centralb. f. Chirurg*, 1885, No. 38.

It has been stated that¹ the operation tends to become less fatal in any place as the years go by. In Berlin² the death-rate after operation fell 22 per cent. in six years, and in Paris,³ at the Hôpital des Enfants Malades, it fell nearly 30 per cent. in six years.

In 11,696 cases reported by Agnew,⁴ in 1878, the recovery per cent. was 26.25. In 1137 cases reported since then which were grouped merely for comparison on this point, the recovery rate was 33.8 per cent. But in the present series of cases no such result was noted. From 1881 to 1885 the recovery per cent. fell from 35 to 26; in 1886 it rose again to 29, but the general tendency has been downward, a fact which is probably dependent on the extension of the operation to more and more hopeless cases each year. Moreover, Wanscher,⁵ in Copenhagen, in several years noted no such falling off in the fatality per cent. Statistics definite enough to clear up the point are too few.

It became apparent while studying the cases that there was a marked variation in the proportion of recoveries at the different seasons of the year. Therefore, a calculation was made of the average monthly mortality per cent. in each of the twelve months for five years preceding 1886, and the result is shown graphically in Table I. It will be seen that in the winter months the smallest proportion of cases recover, not 20 per cent. in December, February, and March, while from the latter month the recovery rate rises until July, when about 60 per cent. of all cases operated on get well. In a general way, each year showed the same tendency when considered by itself. As a matter of interest, the per cent. of mortality from diphtheria in the city at large was calculated by the month for the same five years from the tables of the Board of Health,⁶ and a very striking correspondence was noticed. The diphtheria mortality per cent. curve is shown in Table IV.

To see if the tracheotomy mortality per cent. bore a similar relation to other zymotic diseases than diphtheria, the monthly mortality per cent. of scarlet fever (chosen only as a representative) for the same five years was calculated for the whole city, and the result is shown in Table VII.

By comparison of these three tables it will be seen that from 1881 to 1885 inclusive, the tracheotomy death-rate at the Boston City Hospital varied by the month in the closest correspondence to the mortality per cent. of diphtheria for the same time in the whole city of Boston, and

¹ Hugonniat: Das erste 100 Croup Operationen in Zürich. Inaug. Diss., Zürich, 1878.

² Krünlein: Archiv f. klin. Chir., Bd. xxi. Heft 2.

³ Bourdillat: Bull. et Soc. Méd. Hôp. Paris, 1867, 39.

⁴ Agnew: System of Surgery, vol. iii.

⁵ Wanscher: Om Diphtheritis og Croup saerlight med. Hyensyen til Tracheotomien ved Samme for Doctor graded i Medicinen. Kjøbenhavn, 1877.

⁶ Reports of the Boston Board of Health, 1881-85.

that it did not vary at all in correspondence with the death-rate from scarlet fever in the whole city. Nor does it correspond to the general monthly mortality of the city for all diseases during the same five years. In a word, when diphtheria is most fatal in the city, tracheotomy is most fatal at the hospital. That this variation is not due to the greater prevalence of scarlet fever or diphtheria at different seasons is shown by Tables II. and V., which show the monthly number of cases reported for the five years of each disease. It is also of much interest to see how closely the number of deaths from croup and diphtheria in the whole city correspond when considered by the month in the same way. (Table III.) The same correspondence was noted for 1876-77 by Dr. F. W. Draper.¹

It does not come within the scope of this paper to enter upon any discussion as to the identity of croup and diphtheria; at the same time it is easy to see that the correspondences and variations noted above lend a very strong weight to the assertion that croup and diphtheria are one and the same disease. However it may be in other places, idiopathic, non-diphtheritic croup is very rare in Boston; whether it exists at all is questioned by many. The overwhelming majority of all cases coming for operation to the hospital present some signs of diphtheritic infection, membrane in the throat or nose, enlarged glands in the neck, albuminuria, septicæmia, and the like.

If the seasonal death-rate from diphtheria in a city affects the tracheotomy death-rate so much as our tables would seem to show, we should expect that in cities where a low death-rate from diphtheria prevails unusually favorable results would follow tracheotomy. And this may account for the otherwise inexplicable figures given by Wanscher, of Copenhagen, where of 400 cases operated on in hospital practice 42 per cent. recovered. The table shows the rest.

	To the 1000 of the living population.
General death-rate in Copenhagen, 1880-1885 . . .	22.8
General death-rate in Boston, 1880-1885 . . .	22.5
Diphtheria death-rate in Copenhagen, 1880-1885 . . .	0.25
Diphtheria death-rate in Boston, 1880-1885 . . .	1.35

Unfortunately, statistics are not to be obtained for similar investigation in other cities.

The presence of membrane in the pharynx is by no means an invariable accompaniment of the laryngeal trouble, for it was noted as having been present in the pharynx in 158 cases and absent in 93, while in 76 there was no definite note. It was undoubtedly seen but not noted in

¹ Reports of Boston Board of Health, 1877-78.

many cases, whereas nearly every case in which it was absent was probably entered in the notes, so that the figures given above by no means represent the true proportion. But the interest of the two classes of cases lies in the difference of their death-rates. Of the 158 cases where membrane was present in the pharynx at the time of operation 44 or 28 per cent. recovered, in the 93 cases where membrane was absent from the pharynx 37.6 per cent. recovered.¹ That this difference in the per cent. is not due to the fact that the cases where membrane was absent were older children, is shown by the average age of the two classes:

Where membrane was present the average age of the 158 cases was 4.4 years.

Where membrane was absent the average age of the 93 cases was 4.1 years.

That is, in spite of the fact that the children were younger, 10 per cent. more recovered where membrane was not present in the pharynx at the time of operation.

In the majority of cases the attack of croup had been preceded by illness varying from one to seven days in duration. Oftenest there was the history of an attack of pharyngeal diphtheria preceding, but sometimes there had only been a day or so of general malaise without definite throat symptoms. In an average of 225 cases the attack of croup came on the fifth day of the illness, and in only 10 cases was the croup not preceded by at least one day's illness.

Perhaps the most important question of all is the influence of early or late operation as it affects recovery, as it is one of the very few conditions under the control of the surgeon. The table shows the recovery-rate in cases operated upon within one, two, three, and four days after the beginning of the obstructed respiration.

Day of operation.	Number of cases.	Recovery.	Per cent. of recovery.
1	123	40	32.5
2	86	24	28.0
3	33	8	25.3
4	7	1	14.0

In the same line of argument the amount of the patient's dyspnœa at the time of operation serves to advocate the performance of tracheotomy while the dyspnœa is yet moderate. In 154 cases the dyspnœa before operation was noted as "severe;" of these, 21 per cent. recovered. In 124 where it was noted as "moderate," 35 per cent. recovered. The argument against early operation is of course the possibility of a patient's recovery from even severe dyspnœa without tracheotomy; on this point

¹ Honsell: *Aerztl. Mittheil. aus Baden*, xxxvi., 1882.

authorities differ very widely. Steiner¹ has seen only three recoveries of this sort. Mackenzie² sets the death-rate without operation at 90 per cent., and in 33 cases of croup treated medically many years ago by Dr. John Ware,³ 30 died. On the other hand are arrayed Lewis Smith,⁴ Meigs and Pepper,⁵ and Agnew,⁶ who believe that recovery without operation is more frequent than has commonly been supposed. The experience at the City Hospital has been as follows: forty cases of diphtheritic croup have been treated medically and every one died. Dr. G. W. Gay, visiting surgeon, wrote in 1885,⁷ "Not a single case of pseudo-membranous laryngitis has ever recovered in this hospital without operation." And he quoted Dr. D. W. Cheever, senior visiting surgeon, as writing to him in 1884,⁸ "After reflection I cannot recall a case of membranous laryngitis that I have known to recover without tracheotomy." Since Dr. Gay's article was written there have been two recoveries from moderate dyspnoea without operation.

The age of the patient is, of course, an important consideration, the mortality-rate falls as the age increases, up to eight or ten years. In 1600 cases collected from Cohen,⁹ Schüller,¹⁰ Birnbaum,¹¹ Mastin,¹² etc., and tabulated with regard to the age of the patients, the recovery-rate in children less than two years old was 20 per cent., rising steadily until the age of eight years was reached, when it was 40 per cent. The 327 cases reported here followed much the same course, except in the youngest children, where the operation proved much more fatal. Of 42 patients under two years of age only 3 recovered, 1 eleven months old, and 2 fifteen months old, all nursing children. The oldest case to recover was a girl sixteen years old, and several adults died.

There are several minor symptoms that deserve mention. Nasal discharge was almost always present and had no special significance. When it was associated with severe septicæmia it was ordinarily foul-smelling. Cervical glandular swelling, in the same way, was generally present, being noted as absent in only 24 cases. It was present in all sorts of cases, and its only significance was that when it gradually increased after operation, death from septicæmia followed in an overwhelming majority of cases. To be sure, two or three cases got well after having developed an amount of glandular swelling that made the neck

¹ Steiner, quoted by Gay: Wood's Ref. Handbook of Med. Sci., vol. ii. p. 344.

² Mackenzie: Diseases of the Throat and Nose.

³ Ware, quoted by Gay, *Ibid.*

⁴ Lewis Smith: Dis. of Children, Phila., 1881; also Amer. Journ. of Med. Sci., April, 1885, p. 319.

⁵ Meigs and Pepper: Diseases of Children.

⁶ Agnew, *loc. cit.*

⁷ Gay: Wood's Ref. Handbook of Med. Sci., vol. ii. p. 344.

⁸ Gay: Phila. Med. News, July 12, 1884.

⁹ Cohen: Croup in its Relation to Tracheotomy, 1884.

¹⁰ Schüller: Deutsche Chir., Lief 37, Stuttgart.

¹¹ Birnbaum: Arch. f. klin. Chir., xxxi. p. 333.

¹² Mastin: Gaillard's Med. Journ., xxix. 1 p. 1.

double its ordinary size, but in general when the neck tape had to be loosened, after it was once tied in place, it meant death for the patient.

Albumen was present in the urine of five-sixths of all the cases in which an examination was made and recorded (75 in number). It appeared in all classes of cases and was particularly abundant in bad cases of septicæmia. Sugar was temporarily present in the urine of one child who recovered.

The discharge from the trachea tube after operation furnished perhaps the most important indication of a patient's progress. The discharge was classified as loose and as gummy, and the line between the two classes was easy enough to draw ordinarily. The inner tube was always taken out and cleaned every two or three hours, and at these times the character of the discharge taken from it was noted. Sometimes there was no discharge at all, and then the case was classed as "discharge suppressed;" when it was gummy it was always scant. The importance of the tube discharge with reference to the prognosis of the cases is shown in the following table:

	Number of Cases.	Number of Recoveries.	Per cent.
When the discharge was loose throughout	83	53	60
When the discharge was gummy at any time, even temporarily	86	11	13
When the discharge was suppressed	15	0	0

The notes were indefinite in the other 143.

The appearance of blood in the tube discharge was a matter of no significance. It was always present for a while after operation and reappeared in all classes of cases at irregular intervals, sometimes as late as the fifth day after operation.

The temperature possessed no more than its usual significance in acute febrile diseases; when it rose higher than 105° at any time the child rarely recovered. The temperature generally rose several degrees after operation, but it was of no significance unless, as pointed out by Ripley,¹ it remained high, when it could be inferred that the disease was progressing unfavorably. But a marked rise on the third, fourth, or fifth day after operation was the most ominous sign and generally ushered in a fatal result. In the majority of cases the temperature ranged between 99° and 103°.

The treatment in all these years has, of course, varied very much. Of late years the steam pipes in the tracheotomy rooms have been tapped, and for several days after operation every child lies in a cloud of steam coming from these pipes. In former years a hand atomizer was used. Free stimulation and milk *ad libitum* form the treatment of

¹ Ripley: Med. Record, Jan. 24, 1885.

nearly all cases after operation. 66 cases were treated with mercury in small and frequent doses ($\frac{1}{60}$ of a grain of corrosive sublimate or $\frac{1}{4}$ of a grain of calomel every two hours), and the recovery per cent. was 28, and did not differ materially from the recovery per cent. of 156 cases which were treated by steam, brandy, and milk, where 40 cases, or 25 per cent., got well. Quinine was given through the course of the disease in 53 cases, and the recovery per cent. here was 39, much larger than in the other cases mentioned above, but the numbers are altogether too small to warrant any conclusions as to the comparative efficacy of different methods of treatment.

In turn, ipecac, lime-water spray, chlorate of potash, iron, pilocarpine, pepsine, etc., have held the chief place, but the number of cases in which each has figured is too small to be worth analyzing, and iron, quinine, and mercury hold the chief places. In connection with the mercurial treatment, it should be mentioned that an excessive flow of saliva is an occasional accompaniment of laryngeal diphtheria. This was noted in several cases in which mercury was not used at all, and for that reason the drug is probably credited with much salivation for which it is not accountable. In the same way diarrhœa, many times noted after the continued use of calomel in $\frac{1}{4}$ grain doses, often came on where no mercurial had been administered. Young children took $\frac{1}{60}$ of a grain of corrosive sublimate for two or three days, and within that limit they were rarely salivated, and still more rarely did they have diarrhœa. If it was continued longer, or if it was given in larger doses, it was apt to cause one or both. Calomel, on the other hand, was likely to cause diarrhœa, if used even moderately.

When a patient progressed well, on the fifth, sixth, or seventh day the neck tape was cut, and the tube was taken out quietly, without any preliminary testing of the larynx by stopping the tube. In 65 cases of the 95 which recovered, the tube was finally removed by the eighth day (once on the third day, and twice on the fourth), and was not replaced. In 9 cases it was necessary to put back the tube within a few hours of its first removal, and to leave it for a few days more, on account of the difficulty which the child experienced in breathing without the tube. In 4 others it had to be replaced a second time, but it was not worn more than a month altogether in any one of them, while in 4 others it was impossible to remove the tube definitely for periods varying from 3 months to 3 years. These four cases have been reported elsewhere.¹ This difficulty in getting the children to breathe without their tubes at the usual time for so doing did not seem to be due to any unusually early or late time of the first attempt at removal. In most of them, as in the others, the attempt at removal

¹ Lovett: Boston Med. and Surg. Journal, July 22, 1886.

was made on the fifth, sixth, or seventh day, and not until the dyspnoea began (usually some hours after the tube was taken out) was there any indication that matters were to go wrong. These were average cases in every other way.

Diphtheria of the wound was noted in only 6 cases in the 327; 3 of these recovered. In 2 other cases diphtheritic membrane appeared, once on the ear, and once on the lip.

17 times the tracheotomy was done for croup (mostly diphtheritic in type) occurring during the course of the exanthemata, mumps, or whooping-cough. In 10 cases it was a complication of measles, and of these cases 5 recovered. A very unusual state of affairs, if we may believe Cohen,¹ who says, "Croup supervening on the exanthemata is not, as a rule, amenable to tracheotomy," and Settegast² says "Cases of recovery are so rare as to be mentioned individually." The other 7 cases after mumps, scarlet fever, and whooping-cough were all fatal.

The amount of nourishment taken by a patient indicated, of course, in a general way the progress of the case. The children were encouraged to take as much milk as possible, and in many cases were fed every hour. They took from 20 to 40 ounces of milk a day, 30 was a fair amount, and when a child took less than 25 it rarely recovered. Milk came out through the tube and wound in some cases, but it was no very serious matter, for in 7 cases when it was noted, 5 recovered. There were many curious complications in all these cases, but those of practical interest have already been mentioned.

The results of operation in this series of cases are above the average, in spite of the predominance of bad cases. They show that young children are especially liable to have extension of the diphtheritic process to the bronchi and lungs; in fact, that the chances are three to one that if they die they will die of suffocation. That, in Boston, tracheotomy at the hospital is most fatal at those times when diphtheria is most fatal in the whole city, and incidentally that the mortality per cent. from croup and diphtheria in the whole city vary by the month in unison. That cases with membrane in the pharynx at the time of operation are more likely to die than those where it is not present. That the mortality per cent. after tracheotomy rises steadily as the operation is done on the first, second, third, or fourth day of the difficult breathing. That nasal discharge, albuminuria, and enlargement of the cervical glands, are symptoms of less moment than the character of the discharge from the trachea tube, which is the most important index of the progress of a case, and that the recovery-rate varies nearly 50 per cent. between cases

¹ Cohen; Croup in its Relation to Tracheotomy. 1874.

² Settegast: Archiv für klin. Chir., xxiii. 270.

where the discharge is loose throughout and those where it is gummy at any time.

For purposes of comparison, a table of all available reported cases of tracheotomy has been constructed. As a rule, no group of less than five operations has been considered, very few contain less than ten, for the reason that recoveries predominate enormously in the very small groups. The journals are full of accounts of two or three successful cases reported by practitioners who may or may not hint at various failures in the past. It was considered that to count such groups would be misleading, and they were all rejected, whether favorable or not, because they were not considered representative. The cases are arranged by countries, and, so far as it has been possible to tell, no cases have been reported more than once.

	Total.	Recovered.	Died.	Per cent. Recovered.
German authors	5795	1851	3944	31
German hospitals	3063	939	2124	30
British authors	433	138	295	31
French authors	9242 ¹	2242	6834	24
Various countries	1993	657	1336	32
American authors	1327	308	1019	23
	21,853	6135	15,552	28

¹ 166 not healed.

